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Expected effects of the Gabčikovo river barrage system on the ichthyofauna of the Szigetköz and its values

by
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Abstract: On 25 October 1992, Slovakia diverted the main channel of the river Danube at Cunovo. As a result, the water types and as a consequence, their fishfauna of the Szigetköz located below this point were negatively affected, though to a different degree.
Key words: Fishfaunal changes, hydropower dam, threatened fishes, Gabčikovo river barrage system, Szigetköz

Introduction

The Czechoslovakian and Hungarian governments agreed in 1977 to construct a 200 km long joint barrage system on the shared part of the river Danube. The new political system in Hungary suspended the Hungarian participation, while the (then) Czech and Slovak Republic decided to continue and eventually to complete the project. In turn, Hungarian scientists started multidisciplinary studies on the assessment of the possible environmental effects of the damming and other water regulations.

The planned barrage system consists of three dams. The lowermost one at Nagymaros (40 km upstream of Budapest) was planned in a wholly Hungarian territory, and its construction was interrupted in 1989 in a still preparatory phase. The middle dam is located at Gabčikovo, Slovakia, and has recently been completed. The uppermost barrage serves as a river diverting system directing the river into the artificial channel leading to the hydroelectric power dam of Gabčikovo (=Bős). Consequently, most of the original river flow is diminished causing drastic modification (degradation) of the landscape and its ecosystems, eliminating one of the very few surviving potamofaunal "paradises" of Europe.

On 25 October 1992, the Slovakian party opened the artificial channel at Cunovo (=Dunacsún), to start the operation of the hydroelectric power dam. With this unexpected measure, which was taken without considering ecological consequences, all the previous agreements were violated. As a result, downstream Cunovo, most of the water of the side-branch systems of the Danube in the so called "Szigetköz" (Hungary) and "Csallóköz" (Slovakia) areas disappeared within few hours. Approximately 70 percent of the side-branches located in the Szigetköz area became dry. Only a handful of patches of water remained in the once flooded areas, and these loose their respective surfaces continually, due to decreasing ground water levels. The unexpected inundation arriving at the end of November 1992 brought the water back to the flood-plain, but the process itself as described above, continues.

A general description of the Szigetköz is to be found in Vida (1990a, 1990b, 1993).

Material and methods

Taking into account the changes observed in the months following the diverting of the Danube (from October 1992 to March 1993), I attempt to predict the expected ichthyofaunistical tendencies. As a basis, the ecological requirements of the individual species were considered (Balon 1964, Bănărescu 1964, Berinkey 1966, Holčik 1982, Lelek 1987, Pintér 1989, Sokolov & Vasilev 1989). Besides, the results of complete ichthyofaunistic surveys of the past ten years (Vida 1990a, 1990b, 1993) and the expected habitat changes were used to make assessments. Lelek's (1989) work was followed in the categorizing of the individual fish species, which is was based on their status on European level.

The three time categories used throughout this study (before October 1992, a few months later, and a few years later) refer respectively to the conditions prior the diverting of the Danube, to the few months past since then (from October to March) and to the period after conditions will have become stabilized after these rapid changes. The third category (prognosis) is thought to be valid only when the started processes continue without human interactions intended to reduce their effects.

Regarding the Gabčikovo river barrage system, two works deal with the expected ichthyofaunistical changes. In the papers by Tóth (1983) and Holčik *et al.* (1981) the predicted negative effects on the ichthyofauna are also considered. For a qualification of their species lists see Vida (1993). Schiemer & Spindler (1989), like the authors mentioned before, qualify the effects of the Austrian barrages as negative on the fish fauna of the upper Danube-reach, eventhough the ichthyofauna appears to be, based on their investigations, much more poor than that of the Szigetköz.

Collectings were made monthly in the period following the diverting of the Danube, the material and methods being similar to those described in Vida (1993).

This study deals with all water types found in the Szigetköz, except the Bagamér side arm system, where no changes are expected to occur due to the diverting.

Results and discussion

The individual water types found in the Szigetköz area have already differently sustained or will sustain injury due to the diverting of the Danube, and are thus discussed separately in this study.

The main channel (Danube River)

The main channel in the Szigetköz area is of a sub-montane riverine character, with fish species bound to this water type (*Barbus barbus, Chondrostoma nasus, Zingel zingel,* etc.). Besides these characteristic species, prealpine elements are to be found in great numbers. As this area is part of the migratory route of ponto-caspian species, its assemblage contains some rare elements, i.e. *Caspialosa kessleri pontica, Coregonus lavaretus* and *C. albula. Thymallus thymallus* possibly occurs here as well. Other species forming this assemblage have also a primarily ponto-caspian distribution. The elevation is reduced by 19 m in 56 km (40 cm/km) and the drift speed is as high as 2.5 m/s, being unique within Hungary, so numerous rare, rheophilous fish species *(Pararutilus frisii meidingeri, Gobio kessleri, Gymnocephalus schraetzer, Zingel streber)* occur here.

Taking these facts into consideration, it is easy to understand, that on this 60 km long reach the number of fish species (n=57) was extremely high before the Danube divertion. After the divertion, the main channel ennarrowed and lost its contacts with the tidal zone, the littoral zone of which was especially important from the fish biological point of view. In addition, it lost most of its contacts with

the side branch systems of the flood-plain, the diversity of which was for many species indispensable. The species found in the main channel spawned in the side arm systems, and the different phases of fry development took place in this part as well. The following rheophilous, stenoecious species form an exception in this respect as they spawn in the main channel itself: *Zingel zingel, Z. streber, Gymnocephalus schraetzer, Salmo* spp., *Hucho hucho, Thymallus thymallus* and *Gobio kessleri.*

For this reason, the sub-montane character of the main channel is expected to change on the short run, and of the previously registered 57 species only 36 species will probably survive. These are usually those that are considered common in Hungary. However, even these species will occur in much lower numbers, thereby lowering the genetic value of the individual populations.

Species probably disappeared in the past few months: *Thymallus thymallus, Salmo trutta m. fario, S gairdneri, Hucho hucho, Chalcalburnus chalcoides mento, Phoxinus phoxinus, Pararutilus frisii meidingeri, Zingel streber.*

Species expected to disappear within a few years: *Eudontomyzon mariae, Acipenser ruthenus, Caspialosa kessleri pontica, Coregonus albula, C. lavaretus, Alburnoides bipunctatus, Gobio kessleri, Pelecus cultratus, Cottus gobio, Gymnocephalus schraetzer, Zingel zingel.*

Species expected to suffer serious population decline: *Anguilla anguilla, Esox lucius, Cyprinus carpio, C. carpio m. hungaricus, Abramis brama, A. ballerus, A. sapa, Alburnus alburnus, Aspius aspius, Barbus barbus, Blicca bjoerkna, Carassius auratus, Chondrostoma nasus, Ctenopharyngodon idella, Gobio albipinnatus, G. gobio, Hypophthalmichthys molitrix, H. nobilis, Leuciscus cephalus, L. leuciscus, Rutilus rutilus, R. pigus virgo, Vimba vimba, Cobitis taenia, C. aurata, Silurus glanis, Lota lota, Perca fluviatilis, Gymnocephalus baloni, G. cernuus, Stizostedion lucioperca, S. volgense, Proterorhinus marmoratus.* Some of these species are positively affected, but are included in this list due to habitat loss.

Species expected to be indifferent as regards to the changes: *Pseudorasbora parva, Rhodeus sericeus amarus, Noemacheilus barbatulus, Lepomis gibbosus.*

Qualification of the main channel in the Szigetköz area and the expected changes according to the number of valuable fish species are shown in Fig. 1.

All categories used throughout this study (endangered (e), vulnerable (v), rare (r) and intermediate (i)) after Lelek (1987).

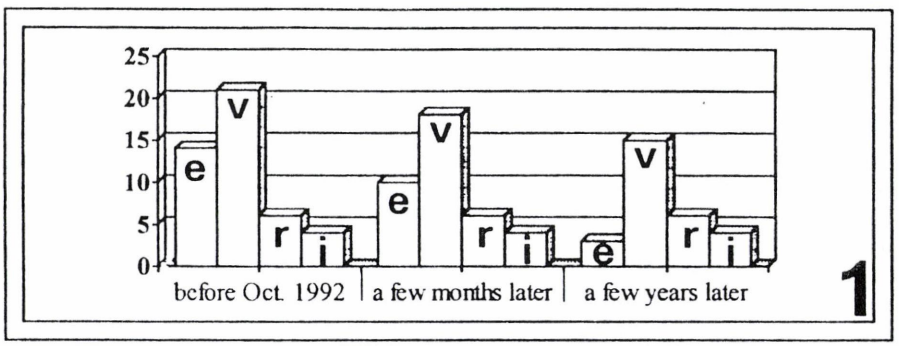

Fig. 1. Qualification of the main channel in the Szigetköz area and the expected changes according to the number of valuable fish species.
All categories used throughout this study (endangered (e), vulnerable (v), rare (r) and intermediate (i)) after Lelek (1978).

Side branch systems in the flood-plain

The side branch systems of the flood-plain are located at the meeting points of various biogeographical zones. They are characterized by a great diversity of habitats. Not only the species native here, but also those occurring in the main channel or migrating from large distances (several hundred kilometres) spawn regularly in this area. Therefore the species number (n=52) is very high. The loss of the side arm systems will thus negatively affect the fish fauna of the Danube itself downstream the Szigetköz area.

The existence of a connection between the various water types could have guaranteed the conservation of the fishfaunistic values found in this area. However, water disappeared from most of the side arm systems in the flood-plain. The fish fauna found its way to the main channel, where even the most elementary conditions are lacking for the survival of the species characterizing the side branches (e.g. *Esox lucius, Cyprinus carpio, Scardinius erythrophthalmus, Abramis sapa, Leuciscus idus, Tinca tinca, Perca fluviatilis).* This is also critical that the fish could not acquire the body condition necessary for hibernation, as their intensive feeding was impossible at the time of the diverting. The required amount and quality of food was lacking in the main channel all over. Those species that already started hibernating, became stuck to the few remaining water bodies and were eventually eliminated due to continuing habitat loss or the intense "activities" of fishermen. The inundation that arrived at the end of November 1992, filled up the side-branches again with water, but could not sufficiently change the situation. The individuals that survived settled again in the side-arms, but after the inundation was stopped their habitats disappeared. The level in the water bodies of the flood-plain has slowly reached that of the ground water, and will continually follow its fall. In the period following the divertion of the Danube, some of the water bodies freezed to their bottoms several times. The fish that were forced to hibernate here could not survive the winter. Even those that were stuck to deeper parts had insufficient condition for hibernation, and their survival chance is very questionable.

Species probably disappeared in the past few months: *Eudontomyzon mariae, Salmo trutta* m. *fario, Gobio kessleri, Pelecus cultratus, Cobitis aurata, Cottus gobio, Gymnocephalus schraetzer.*

Species expected to disappear within a few years: *Acipenser ruthenus, Cyprinus carpio m. hungaricus, Gobio albipinnatus, Leuciscus leuciscus, Rutilus pigus virgo, Lota lota, Gymnocephalus baloni.*

Species expected to suffer serious population decline: *Anguilla anguilla, Cyprinus carpio, Abramis brama, A. ballerus, A. sapa, Aspius aspius, Barbus barbus, Blicca bjoerkna, Chondrostoma nasus, Ctenopharyngodon idella, Gobio gobio, Hypophthalmichthys molitrix, H. nobilis, Leuciscus cephalus, L. idus, Vimba vimba, Cobitis taenia, Noemacheilus barbatulus, Silurus glanis, Gymnocephalus cernuus, Stizostedion lucioperca, S. volgense.* Some of these species are positively affected, but are included in this list due to habitat loss.

Species expected to be indifferent as regards to these changes: *Umbra krameri* (occurrence not verified by specimens), *Esox lucius, Alburnus alburnus, Carassius carassius, C. auratus, Leucaspius delineatus, Pseudorasbora parva, Rhodeus sericeus amarus, Rutilus rutilus, Scardinius erythrophthalmus, Tinca tinca, Misgurnus fossilis, Ictalurus nebulosus, Lepomis gibbosus, Perca fluviatilis, Proterorhinus marmoratus.*

Qualification of the side branch systems in the flood-plain and the expected changes according to the number of valuable fish species are shown in Fig. 2.

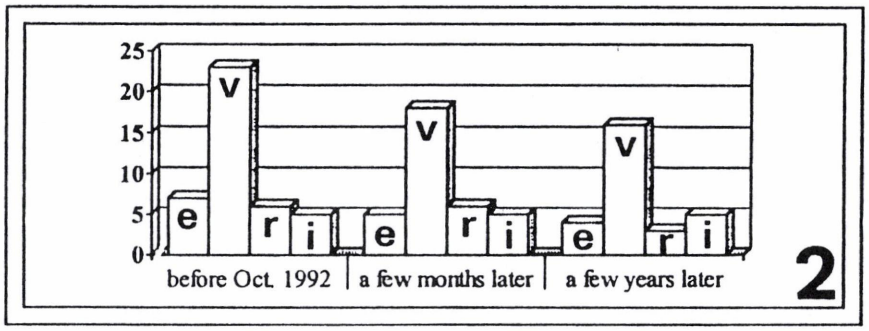

Fig. 2. Qualification of the side branch systems in the flood-plain and the expected changes according to the number of valuable fish species.

Disconnected backwaters

The disconnected backwaters became isolated from the flood-plain due to older regulating activities. Their fish fauna was already formed and stabilized before the divertion. The special physical and chemical parameters are tolerated only by a few species. Most of these species are, due to the loss of such water types, endangered. *Umbra krameri* occurs here, which is endemic to the Carpathian Basin, and is included in the Red Data Book of Hungary (Bankovics 1989). The assemblage of this water type is typically marshy.

Due to the divertion, the water disappeared from practically all disconnected backwaters, so their fauna can be regarded as eliminated. The few short reaches that could have remained were so shallow that the birds and other piscivores probably consumed the last surviving specimens. Characteristic species: *Umbra krameri, Cobitis taenia, Misgurnus fossilis, Carassius auratus, Tinca tinca,* etc.

Species probably disappeared in the past few months: all species, i.e. *Esox lucius, Umbra krameri, Cyprinus carpio, Alburnus alburnus, Carassius carassius, C. auratus, Ctenopharyngodon idella, Gobio gobio, Leucaspius delineatus, Leuciscus cephalus, L. idus, Pseudorasbora parva, Rhodeus sericeus amarus, Rutilus rutilus, Scardinius erythrophthalmus, Tinca tinca, Cobitis taenia, Misgurnus fossilis, Noemacheilus barbatulus, Gasterosteus aculeatus, Lepomis gibbosus, Perca fluviatilis, Proterorhinus marmoratus.*

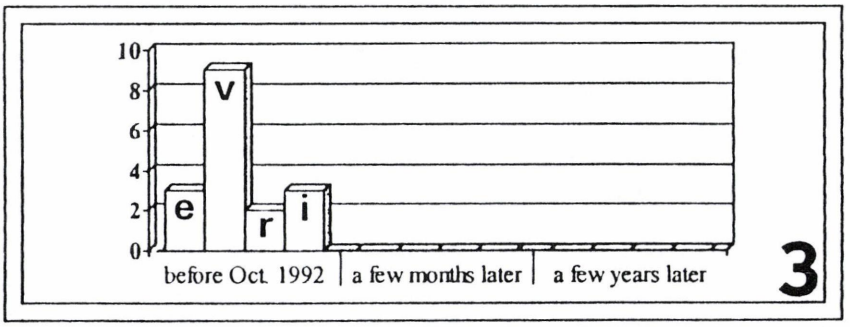

Fig. 3. Qualification of the disconnected backwaters and the expected changes according to the number of valuable fish species.

Qualification of the disconnected backwaters and the expected changes according to the number of valuable fish species are given in Fig. 3.

Irrigation canals

The regulation of the main channel in the last century affected the whole water system of the Szigetköz. At the time of inundation in the Danube, springs occurred in a broad zone on the disconnected side. For this reason, between 1896 and 1900 irrigation canals were built, the system of which has a length of approximately 300 km today. During their construction old and dry Danube basins were used, but generally their banks are mostly straight, regular. They are regularly cleaned, and thus have open water surface. Interesting areas from the ichthyofaunistical point of view could only develop at natural and artificial obstacles (bridges, trees fallen into the water, meanders) and in weedy parts.

The species *Gobio albipinnatus* and *Umbra krameri* deserve particular interest, both being protected and endangered in Hungary (and on the European level as well, Lelek 1987).

Due to the diverting, the water level in the canals fell significantly, their flow was reduced or they became stagnant. For this reason, the status of the rheophilous species became critical. As the effects of the interaction are delayed due to the exclusive contacts with the ground water, the ultimate results will be evident only months later.

Species probably disappeared in the past few months: *Eudontomyzon mariae, Cyprinus carpio, Leuciscus leuciscus, Ictalurus nebulosus.*

Species expected to disappear within a few years: *Esox lucius, Umbra krameri, Blicca bjoerkna, Carassius auratus, Gobio albipinnatus.*

Species expected to suffer serious population decline: *Alburnus alburnus, Ctenopharyngodon idella, Gobio gobio, Leuciscus cephalus, L. idus, Rutilus rutilus, Cobitis taenia, Noemacheilus barbatulus, Perca fluviatilis.* Some of these species are positively affected, but are included in this list due to habitat loss.

Species expected to be indifferent as regards to these changes: *Carassius carassius, Leucaspius delineatus, Pseudorasbora parva, Rhodeus sericeus amarus, Scardinius erythrophthalmus, Tinca tinca, Misgurnus fossilis, Lepomis gibbosus, Proterorhinus marmoratus.*

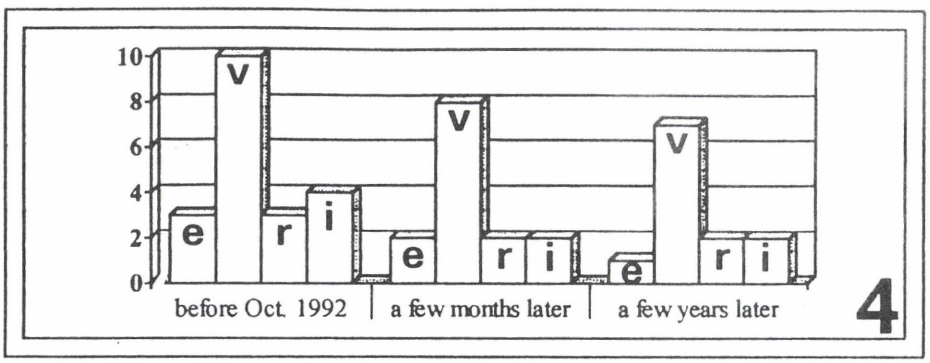

Fig 4. Qualification of the irrigation canals and the expected effects according to the number of valuable fish species.

Qualification of the irrigation canals and the expected effects according to the number of valuable fish species are shown in Fig. 4.

Mosoni-Duna

The southern frontier of the Szigetköz is formed by the Mosoni-Duna. As compared to the main channel, it has a slow current, and is similar to the side-branches. Several rivers of the Hungarian side flow into the Mosoni-Duna, such as the Rába, the Rábca and the Lajta. Its water level and faunistic assemblage are also determined by those of the other rivers.

Like the side-branches, the Mosoni-Duna also had a rinsed character, so both strong currents and stagnant water bodies occurred. The fish species migrate according to the water changes, therefore the inflowing rivers are of primary importance (Rába, Rábca, Lajta). The irrigation canal system in the Szigetköz is in exclusive contacts with the Mosoni-Duna, so its fish fauna is determined by this effect as well. According to personal communications, the occurrence of the extremely rare *Rutilus frisii meidingeri* in the delta area can be assumed. Another species, *Rutilus pigus virgo* was recorded several times from the deltas of the inflowing rivers. From the stenoecious, rheophilous species of the Rába River, *Zingel zingel, Z. streber, Cobitis aurata* and *Gymnocephalus schraetzer* occasionally are found in the Mosoni-Duna.

The ichthyofauna of the Mosoni-Duna downstream the Lajta River (approximately at the level of Mosonmagyaróvár) was affected only slightly. The rivers entering the Mosoni-Duna in this area (Lajta, Rábca, Rába) can make the resettlement of the species possible. The status of the reaches upstream is more critical. The largest *Gasterosteus aculeatus* population within Hungary is found here, which is apparently the only significant and published one for this species.

Species probably disappeared in the past few months: *Pararutilus frisii meidingeri.*

Species expected to disappear within a few years: *Chalcalburnus chalcoides mento.*

Species expected to suffer serious population decline: *Eudontomyzon mariae, Acipenser ruthenus, Anguilla anguilla, Alburnoides bipunctatus, Barbus barbus, Chondrostoma nasus, Gobio albipinnatus, G. kessleri, Leuciscus leuciscus, Pelecus cultratus, Phoxinus phoxinus, Rutilus pigus virgo, Vimba vimba, Silurus glanis, Lota lota, Gymnocephalus schraetzer, Zingel zingel, Z. streber.*

Species expected to be indifferent as regards to these changes: *Esox lucius, Cyprinus carpio, C. carpio m. hungaricus, Abramis ballerus, A. brama, A. sapa, Alburnus alburnus, Aspius aspius, Blicca bjoerkna, Carassius carassius, C. auratus, Ctenopharyngodon idella, Gobio gobio, Hypophthalmichthys molitrix, H. nobilis, Leuciscus cephalus, L. idus, Pseudorasbora parva, Rhodeus sericeus amarus, Rutilus rutilus, Scardinius erythrophthalmus, Tinca tinca, Cobitis taenia, C. aurata, Misgurnus fossilis, Noemacheilus barbatulus, Lepomis gibbosus, Gasterosteus aculeatus, Perca fluviatilis, Gymnocephalus cernuus, Stizostedion lucioperca, S. volgense, Proterorhinus marmoratus.*

Qualification of the Mosoni-Duna and the expected effects according to the number of valuable fish species are given in Fig. 5.

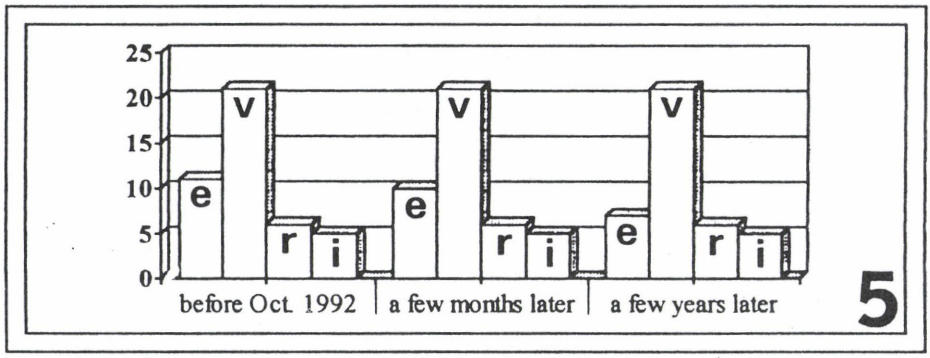

Fig. 5. Qualification of the Mosoni-Duna and the expected effects according to the number of valuable fish species.

Conclusions

1. Most of the fish disappeared from the Szigetköz, the most sensitive being the rare (valuable) species.

2. 38 percent of the fish species found in the Szigetköz (n=65) is falling under any of the four threatened categories of Lelek (1987), while species endemic to East Europe *(e.g. Umbra krameri)* are left beyond consideration. On the national level, 25 percent of the species (n=16) is protected (MN Elnöki Tanács 1982, 1988).

3. On the European level (Lelek 1987) the number of endangered species is 14 (22%), number of rare species is 14 (22%) and number of vulnerable ones is 22 (43%).

4. Amount of fish disappeared or perished according to the annual fishing statistics (the annual fish catch multiplied by 3 to 5) 150-450.000 kg, accounting for several millions of individuals.

Due to the divertion, the populations of 91 percent (n=59) of fish species in the Szigetköz has reached a critically low level. From these, 45 percent (n=29) is expected to disappear within a few years, while 9 percent (n=5) has probably already disappeared.

5. The ratio of area of the main channel and flood plain to number of fish species in the Szigetköz, as compared to other fish assemblages in Europe, is prominent: 6000 ha/65 species, being probably one of the highest among comparable sub-montane zones.

6. The processes that started are irreversible from the fish biological point of view. The original assemblage can never evolve in a similar way again. When one intends to conserve the valuable species in this area, constant interactions and control are needed. These species can, however, usually not be bred in captivity, and specimens originating elsewhere do not guarantee for the genetic values of the populations in the Szigetköz.

7. The population decrease will cause a decrease also in genetic resources of less affected areas and species.

8. The species disappeared or perished can usually not be bred under artificial circumstances. The species important from the economical point of view can be reproduced in captivity, but these are not those that disappear. Our knowledge

of the life history, reproduction and habits of the rare fish species *(Eudontomyzon mariae, Abramis ballerus, A. sapa, Gobio albipinnatus, G. kessleri, Rutilus pigus virgo, Cobitis aurata, C. taenia, Misgurnus fossilis, Umbra krameri, Gymnocephalus baloni, G. cernuus, G. schraetzer, Zingel zingel, Z. streber,* etc.) is poor.

9. From the fishes of the flood-plain, those that started to hibernate probably became stuck to the isolated, deeper parts of the side-branch systems. For this reason, they could not survive the winter. The level of the remaining water bodies in the flood-plain sank to the level of the ground water, in a period when the species were inactive. Most of them froze or dried. Those that successfully hibernated are in such a bad condition that they can not reproduce in spring, and due to the loss of their habitat they can regenerate only with difficulties.

Most of the species of the flood-plain that found their way to the main channel could not hibernate there, their condition deteriorated, the specimens died or were consumed by carnivores.

Summarizing, the selected time of the divertion fell into a period critical from the ichthyofaunistical point of view.

10. When the seasonal changes in water level will no more occur in these areas, spawning, fry development and hibernating will be problematic, all these being based on cyclic hydrological conditions. The hibernating, spawning, feeding and fry development sites do not overlap, so the mosaic-like water bodies can no more function. Migratory species (e.g. *Vimba vimba*), which live in other reaches of the river Danube, regularly spawned in the side-branch systems of the Szigetköz area. So the loss of spawning sites will affect the fish fauna of the lower reaches of the Danube as well.

11. The disconnected backwaters have practically disappeared, together with their fish populations. From the whole of the Szigetköz, the nationally protected *Umbra krameri,* which is endemic to the Carpathian Basin is only recorded with certainity from this area.

12. Of all the water bodies of the Szigetköz, the Mosoni-Duna is the only one that has slightly been affected because of its connections with the Lajta, Rábca, Rába and Marcal rivers.

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